

# Goddard Space Flight Center

## FY05 IRAD Proposal

### Next Generation Science and Exploration Systems

#### Expansion of 10-Gbps Lambda Network (L-Net) Within GSFC

##### Abstract

This effort will extend GSFC's 10 gigabit per second (Gbps) Lambda Network (L-Net), initially developed under the GSFC FY04 IRAD-funded project "Preparing Goddard for Large Scale Team Science in the 21st Century: Enabling an All Optical Goddard Network Cyberinfrastructure", to additional GSFC buildings, computers, and users to increase the number and type of GSFC science/exploration research projects that benefit from the increased throughput performance that multi-wavelength optical networking can provide. This effort also will research and evaluate new transport layer protocols such as FAST and High Speed TCP that are particularly more suited than TCP Reno in delivering increased end-to-end throughput performance in high bandwidth\*delay networks. In FY04 GSFC's L-Net effort primarily focused on establishing membership with and initial use of the National LambdaRail (NLR) as the optical wide area network (WAN), and setting up the Dynamic Resource Allocation via GMPLS Optical Networks (DRAGON) between McLean, VA, and GSFC as the optical metropolitan area network (MAN), for enabling advanced connectivity between GSFC and a few remote research sites and/or projects such as the Scripps Institute of Oceanography, the University of California San Diego's OptIPuter project, and the ARC-based Project Columbia supercomputer facility; and within GSFC the FY04 L-Net effort primarily focused on proof-of-concept 10-Gigabit Ethernet (GE) connections with the *thunderhead* Beowulf cluster and the SVS' Hyperwall, both within the same GSFC building. In FY05, as the optical NLR WAN and DRAGON MAN extend to more sites, the L-Net is proposed to be extended within GSFC to several more science/exploration research projects that are interested in experimenting with new distributed compute/data-sharing facilities and real-time, grid-based, interactive collaborative approaches that are not feasible over traditional/non-optical networks.

##### Principal Investigator

Name: J. Patrick Gary  
Organization: 930  
Telephone: 301-286-9539  
E-mail: Pat.gary@nasa.gov

##### GSFC "New Innovator" Candidate

*Check here if PI has less than five year's professional experience*

##### Division/Laboratory Chief Concurrence

Name: Dr Richard B Rood  
Organization: 930  
Signature:

**Technical Objectives and Approach**

The primary objective is to improve GSFC’s competitive position in science/exploration research and applications by leveraging the nation’s newest cyber infrastructure involving multi-wavelength optical networking technologies with 10-GE per wavelength and new transport layer protocols particularly suited to delivering increased throughput performance in large bandwidth\*delay networks. The plan leverages the respective national and regional buildouts of the NLR <<http://www.nlr.net/>> and DRAGON <<http://dragon.east.isi.edu/>> optical networks with whom we’re partnered, major NSF-funded cyber infrastructure R&D initiatives such as the OptIPuter <<http://www.optiputer.net/>> and GEON <<http://www.geongrid.org/>> with whom we’re also partnered, the ARC-based NREN Project’s commitment to enabling all NASA Center’s access to the Project Columbia supercomputer facility via the NLR, and GSFC’s FY04 IRAD-funded effort which successfully initiated the interconnection with and utilize of those networks and projects in new science/exploration collaborations via the GSFC 10-Gbps L-Net.

The longer term goal includes enabling multiple 10-GE and higher speed L-Net connections as needed for any and all GSFC compute clusters, scientific visualization stations (vis), and/or storage area networks (SAN’s) requiring such connectivity with other clusters/vis/SAN’s either elsewhere within GSFC or remote. And via the on-going efforts of GSFC’s IT Pathfinder Working Group (ITPWG), the need for such connections has initially been identified for several projects underway within GSFC’s AETD and the newly forming Science Exploration Directorate. Near term needs for 10-GE L-Net connectivity, for example, have already been identified for clusters/vis/SAN’s in several GSFC’s buildings.

As the FY05 end-goal, new 10-GE L-Net connections are proposed to be established with at least the following additional GSFC-based clusters:

<u>Cluster Type (# of cpu’s)</u>	<u>Science/Exploration Research Projects (NLR-related remote site)</u>	<u>Project Manager/ Code</u>
Apple G5 (24)	Climate models ensemble runs (GISS)	Mike Seablom/586
SGI Origin (512)	CXFS SAN-over-IP (ARC)	Ricky Rood/930
Apple G5 (22)	Invasive species (CSU)	John Schnase/930
TBD (TBD)	ECHO L-Net testbed (MSFC & JPL)	Robin Pfister/586/423
Intel P4 (256)	CEOP re-analyses (SIO)	Mike Bosilovich/900.3
Intel P4 (16)	Earth core dynamics modeling (UCSB)	Weijia Kuang/926

In addition to the above projects’ identification by the ITPWG, and consideration for limiting this proposal’s funding request, some other key factors used in selecting the above projects’ clusters/vis/SAN’s for L-Net connectivity at this time are interests in researching and demonstrating L-Net’s design extension to at least one more building on GSFC’s West campus served from the L-Net’s initial 10-GE switch/router “hub”, and in deploying another inter-connected L-Net 10-GE switch/router “hub” on GSFC’s East campus serving clusters/vis/SAN’s in multiple buildings.

The top-level schedule, milestones, and deliverables include:

<u>Milestones &amp; Deliverables</u>	<u>Schedule</u>
O Complete specification & submit PR’s for acquisition of all needed switches/routers award	By 2 months after
O Arrange for inter-building fiber connecting new buildings on both GSFC’s East and West campuses award	By 3 months after
O Demonstrate first 10-GE cluster connection on GSFC’s East campus award	By 6 months after
O Demonstrate additional 10-GE cluster connections	Thereafter at ~1/month

***Justification & Benefits – What future missions, opportunities will be enabled?***

This fits with Goddard’s mission as each of the above clusters/vis/SAN’s already is an integral part of an approved NASA science/exploration program and/or project; and each program/project would benefit via improved connectivity between the GSFC-based clusters/vis/SAN’s and its NLR-related remote site counterpart.

This is appropriate for IRAD consideration because it involves R&D with leading edge optical networking technologies and protocols yet strictly applies to improving a multi-user network infrastructure within GSFC that no single-mission/project within GSFC will address and no fund source outside GSFC would particularly appreciate or consider as their responsibility.

This is innovative in that it involves research, engineering, evaluation, and use of leading edge optical networking technologies and protocols; and it’s compelling in that it leverages the \$80M NLR, the \$6.5M DRAGON, and the \$13.5M OptIPuter projects and positions GSFC more competitively.

Future external opportunities include immediate enhanced possibilities for new distributed compute-/data-intensive research done jointly with remote institutions also connected by the NLR and/or similar international optical networks now emerging in Europe and Asia.

The potential ROI in terms of possible future funding is directly proportional to the square of the number of science/exploration-oriented clusters/vis/SAN’s connected to the L-Net, and correlates positively with upcoming missions/projects with ever increasing data-intensive processing and distribution requirements. This investment improves GSFC’s competitive position by enhancing GSFC’s high performance connectivity with the national/international cyber infrastructure based on multi-wavelength optical network technologies; and it improves in house skills, capabilities, and knowledge advancement by enabling GSFC’s network engineers to expand their working knowledge and research opportunities with new multi-wavelength optical network technologies.

***Budget-***

Requested procurement funds (in \$K):

O Non-recurring new fiber & switch/router hw/sw acquisitions	240
O Maintenance of FY04 IRAD-funded L-Net switch/router hw/sw	60
O Contractor support only for intra-building wiring & hw installs	<u>50</u>
O Total requested procurement funds	350

Labor needs (in fractions of a staff-year (FTE)):

O Civil servants		
o Pat Gary/930	PI & network engineer	0.5
o Bill Fink/933	network engineer	0.5
o Kevin Kranacs/585/933	network engineer	<u>0.5</u>
o Subtotal for civil servants		1.5
O Contractor support only for intra-building wiring & hw installs		<u>0.5</u>
O Total labor needs		2.0

***Technical Equipment Requirements and Dependencies-***

O Existing		
o Use of FY04 IRAD-funded L-Net switch/router hw/sw	Costs covered in maintenance request above	
o Lease of fibers and use of DRAGON MAN	NREN	\$68K/yr expected to be covered by
o Membership fees and use of NLR/MATP	NREN	\$115K/yr expected to be covered by
O Equipment requirements via IRAD process		Costs covered in budget request above
O Equipment via Center’s Technical Equipment budgeting		None